



RESEARCH DEPARTMENT

**VISIT TO THE FLORIDA TERMINAL OF THE A.T. AND T. CO.
TROPOSPHERIC SCATTER COMMUNICATIONS LINK TO CUBA**

Report No. A-055

(1959/21)

**THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION**

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A handwritten signature in dark ink, appearing to read "R.A. Rowden". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

R.A. Rowden, B.Sc. (Eng.), D.I.C., M.I.E.E.

(R.A. Rowden)

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1. INTRODUCTION

During a visit to the United States an opportunity arose to visit the station which had received considerable publicity during the past year from the transmission of television pictures over a tropospheric scatter link between the U.S.A. and Cuba. The link, primarily designed to provide multichannel telephony between the U.S.A. and Cuba, had been engineered to provide two-way transmission of the standard 525-line American television system. The author was fortunate in being able not only to see the link in operation but, before doing so, to discuss the system design with the engineers of the Federal Telecommunications Laboratories (I.T. and T. Corp.) at Nutley, New Jersey.

2. GENERAL

This report gives a brief description of the method and operation of the link and summarises the impressions gained during a very short visit to the Florida terminal on 24th March 1959. It must be emphasized that these subjective impressions of the operation of the link are in no way a substitute for any full report which may subsequently be published by the engineers concerned. A very large amount of performance data has been collected during the past few years and it is likely that this will be available in due course. The intention of these brief notes is to express the opinion of the author, based on his observations in Florida, on the possible application of tropospheric scatter for television transmission in Europe.

The link operates between a point near "Florida City" (nothing but swamp* is visible in any direction!) and Guanabo, Cuba, over a sea path of about 185 miles (298 km). Frequency and space diversity are used, the frequencies being in the u.h.f. television band between 692 Mc/s and 880 Mc/s, authorized by the F.C.C. on a non-interference basis. At the Florida City terminal, transmission is on 840 Mc/s and 880 Mc/s from separate 60 ft (18.3 m) diameter dishes spaced 230 ft (70 m) horizontally and using horizontal polarization. At Guanabo the two frequencies of 692 Mc/s and 740 Mc/s are radiated using vertical polarization. The space diversity is achieved at each terminal by the reception of both the incoming frequencies on each

* known euphemistically as "the everglades"

of the two dishes which are simultaneously used for transmission, the change of polarization assisting in discriminating between the incoming and outgoing frequencies at each of the two dishes. For television transmission the frequency diversity is dispensed with and space diversity only used. It appears that the system has been engineered in this way in order to permit the simultaneous and largely independent transmission of a television picture and the normal multichannel telephony traffic. A technical description of the system is available in the Transactions of the American Institute of Electrical Engineers.¹

3. CHOICE OF OPERATING FREQUENCY

The decision to use frequencies in the u.h.f. band was made because, at the time the station was designed, 10 kW klystrons were available which were suitable. However, since the design of this station, high power klystrons have become available which are suitable for use at 2000 Mc/s and an extension of the station now being designed to provide a multichannel telephony link to the Bahamas will operate in that band and it will be possible then to use smaller dishes for the aerials.

4. PICTURE APPRAISAL

During the visit a television picture was observed on a monitor at the Florida City terminal. The signal originated from an American network programme, was passed over the scatter link to Cuba and returned in the reverse direction to the Florida terminal. The picture quality observed was thus that which had passed over two scatter links in cascade over a total distance of 370 miles (596 km). During the appraisal, which lasted for about one hour on various types of programme material, it was stated by the staff on duty that the median level of the signals passing over the link was that which corresponded roughly to an "average summer day". The main characteristic of the picture was that for a large proportion of the time of the test the difference between the outgoing and incoming quality was indistinguishable, it being borne in mind that the originating programme material — Liberace on 16 mm film, etc. — was not particularly good. However, the one characteristic introduced by the scatter link was occasional momentary fading which resulted in the appearance of noise of duration between a quarter second and one second at intervals of approximately two minutes. These noise bursts did not cumulatively add up to more than a very small proportion of the overall time but it is certain that if a high quality picture — for example, the best type of live studio presentation of B.B.C. standard — was being transmitted the occurrence of the noise bursts would cumulatively become disturbing.

A general impression of the picture quality — and it must be remembered that in fact two scatter links in cascade were being observed — was that a link of this type would be entirely adequate for the transmission of news, sport, and pictures of topical interest ("Cuban Revolutions", for example) but not of sufficiently high standard for the transmission of the best type of studio presentation. Very broadly it may be said that the pictures received were of very much better standard than the average B.B.C. newsreel film but intermediate between the best and poorest quality of Eurovision transmission.

5. SEASONAL EFFECTS

The median field strength over the link was stated to be subject to seasonal effects and these were such that there are some times of the year, notably in February, when the field strength is considerably lower than it was at the time the station was visited and the result of this is that the link could not then be considered to be satisfactory for the transmission of television, although still completely adequate for the transmission of multichannel telephony which is, of course, the purpose for which the link is primarily designed. The effect of the lower median field strength at such times is that on a television picture the frequency of the noise bursts due to momentary weak field is increased and, what is more, the length of duration of each burst may be noticeably increased. The effect of such lowering of the median field was well demonstrated to the author over the double link by the engineers at Florida City who progressively reduced the power of the circuit to Guanabo to a value as low as $\frac{1}{2}$ kW, thus simulating the effect of about a 12 dB decrease in median field. A general deterioration of the picture quality was then observable with the effects noted above becoming more apparent.

6. EFFECT OF CLIMATE ON THE OPERATION OF THE LINK

The system designers were of the opinion that the enhanced propagation due to partial super-refraction occurring frequently in the Gulf of Mexico and Florida Strait resulted in field strength of the order of 12 dB higher than would be expected over the same link in a more temperate climate. Thus, bearing in mind the effects noted in Section 5 where the reduction of the transmitter power of the order of 12 dB had deteriorated the picture quality considerably, it may be stated that a link of the same length would not be satisfactory unless the power could be increased by the order of 12 dB, which is not practicable in terms of transmitter power or aerial gain. However, over a scatter link of this nature the attenuation with distance is such that decreasing the path length by 55 miles (89 km) should increase the median field strength by about 12 dB and thus it may be stated that a similar link should transmit pictures of the quality described in Section 4 over a distance of about 110 miles (177 km) in a temperate region such as North-west Europe.

7. COST AND POSSIBLE USES OF SCATTER FOR TELEVISION PURPOSES

This being one of the first scatter links engineered for television and multichannel telephony over a path of this length, it tended to be rather costly and an overall very rough figure of \$3 000 000 was stated to be the probable cost. It was, however, also stated that a reasonable guess of the cost for a second similar link might be of the order of \$1 000 000.

It is thus clear that, in view of the very high cost of such a link, it would only be possible to consider its use for the transmission of television alone where a sea path exceeding 100 miles (160 km) in length existed between two highly populated areas requiring a common television network. The use of such a link for connecting, for example, the U.K. television network to the outer Scottish islands,

i.e. Hebrides and Shetland, would clearly be uneconomical and, where connection is required involving shorter sea paths, there is no doubt that normal microwave link technique would be preferable. The justification of the high cost of the link between the U.S.A. and Cuba is, of course, clearly the fact that it is primarily intended for the transmission of multichannel telephone traffic.

8. PHYSIOLOGICAL HAZARDS

In view of recent B.B.C. interest in this subject, enquiries were made as to what precautions had been taken to avoid possible danger from the high radiation intensity. It was stated that it was considered that 20 ft (6.1 m) ground clearance from the base of the aerial reflectors was sufficient to give safe clearance in respect of people likely to move into the area in front of the radiators, assuming that there were no large buildings existing in that area.

It was pointed out that an extra 20 ft (6.1 m) of clearance added very considerably to the cost of radiators, especially in the Florida area where they had to be designed to withstand possible hurricane force winds. In the case of the Florida City site, which is effectively at sea level, it was also considered that no danger existed as the area between the transmitting site and the sea was entirely uninhabited swamp land and any people who should be so foolish as to cross the area in front of the radiators were already exposing themselves to considerable danger due to the presence of crocodiles, alligators and poisonous snakes and were not, therefore, likely to expose themselves for any length of time to the additional hazard due to radiation. At the Guanabo terminal in Cuba, which is 180 ft (55 m) above sea level, all land between the site and a roadway below and in front of the site was purchased to preclude any subsequent building development which might otherwise have taken place in an area where the radiation was intense. This, of course, also added considerably to the cost of the system.

9. ACKNOWLEDGEMENTS

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The author is also most grateful to Mr. E. Doll and his staff at the Florida City terminal who went to considerable trouble to demonstrate the link in actual operation transmitting a television signal.

10. REFERENCE

1. Communications and Electronics Section of the Transactions of the American Institute of Electrical Engineers, Vol. 77, No. 35, March 1958.
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